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ABSTRACT

A proposal that the normal reader does not pay attention to individual letters but to sets of features which are characteristic of a word as a whole is presented and tested in this investigation. It was hypothesized that the reader learns (1) to extract distinctive feature information simultaneously from several parts of the configuration and (2) to integrate this information for identification of the whole. Two hundred and sixteen college students were given booklets with six 150-word passages of text. Each passage was printed in one of six typographic styles making use of upper and lower case letters. The subjects were asked to locate 20 words in each passage. The results of the experiments supported the hypothesis that disruption in the total look of the word does not interfere with the reader's ability to identify that word unless discriminability of elements is disrupted, as in the passages where the size of the individual letters was mixed. Even then, the readers coped well with the disruptions. References are included. (NH)

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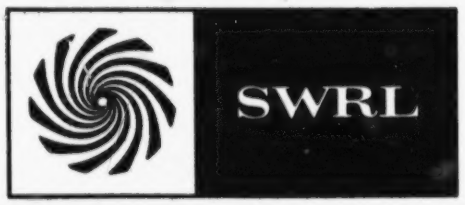

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FUNCTIONAL EQUIVALENCE OF FEATURE COMBINATIONS IN THE VISUAL IDENTIFICATION OF WORDS

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INTRODUCTION

The distinctive feature theory of letter recognition proposed by Gibson (1962, 1965) has been developed to account not only for single letter identification but also for the identification of words and other sequences of letters (Smith, 1967, 1968; Lott & Smith, 1968).

We propose that the normal reader does not attend to individual letters but to sets of features which are characteristic of a word as a whole. This view is essentially a "whole word" approach to word recognition (Anderson & Dearborn, 1952, Pp. 191-3) except that it does not demand familiarity with the total outline or configuration of the

word. Instead it is proposed that the reader learns (i) to extract distinctive feature information simultaneously from several parts of the configuration and (ii) to integrate this information for identification of the whole.

Any minimum combination of features which is sufficient to uniquely determine a particular word (or letter) is termed a "criterial set of features". Sets of features are termed "equivalent" when a single letter or word is represented by more than one feature pattern. For example, A, a, and *a* are equivalent sets of features because they all represent the same letter; and HAT, hat, and *hat* are equivalent because they represent the same word.

Our model asserts that unfamiliarity with the total word form will not affect word identification unless discrimination of distinctive features within the word is impaired. There is, however, evidence apparently contradictory to our view. Anderson and Dearborn (1952, Pp. 191-3) report that material printed in alternating upper and lower case (see Condition 6 in Figure I below) is more difficult to read than either all upper (Condition 1) or all lower case print (Condition 2).

These results could be due to readers not being able to treat upper and lower case letters as "equivalent" when they occur alternately within a word, i.e., our distinctive feature view is not upheld. But, the Anderson and Dearborn results could also be attributed to the fact that the relative size of elements--which is a cue to the discrimination of lower case letters--is interfered with when these letters are mixed with the taller capitals.

We predicted that alternation of upper and lower case would not interfere with the ability to identify words when the size of the capitals was reduced, even though this still results in a configuration unfamiliar to the large majority of readers (Condition 3); but that variation in the size of alternate letters would interfere with word discrimination, even though all the letters were in lower case (Condition 5). We predicted that variation in the size of alternate letters would not affect word identification in all capital text because relative size does not appear to be a cue for discrimination of upper case letters (Condition 4).

RELATIVE SIZE CUE	CASE	EXAMPLE
Irrelevant	Upper	1. THAT WE ARE AS YET QUITE IGNORANT OF EVEN THE SIMPLEST
Maintained	Lower	2. That we are as yet quite ignorant of even the simplest
	Mixed	3. ThAt we ArE as yEt qUiTe IgNoRaNt Of EvEn ThE SiMpLeSt
Irrelevant	Upper	4. tHAT wE aRe As YeT qUiTe IgNoRaNt Of EvEn THE sIMPLEsT
Disrupted	Lower	5. That we are as yet quite ignorant of even the simplest
	Mixed	6. ThAt We ArE As YeT qUiTe IgNoRaNt Of EvEn ThE SiMpLeSt

Figure I

The predictions were tested in an earlier study by measuring the length of time taken by subjects to read a passage printed in the six typographic styles of Figure I. All the predictions were supported (Smith, 1968). Although no special instructions were given with respect to comprehension, and subjects read with normal intonation, the possibility remained that the differences displayed in the earlier study

were not wholly attributable to the ease of identification of individual words. In the present study, subjects were presented with a purely search-and-identification task requiring neither "comprehension" of the text nor verbalization of response.

METHOD

The six typographic conditions were presented to subjects in booklets comprised of six 150-word passages of text. In half of the booklets (Set I) column width was controlled for every line so that equivalent groups of words occupied the same line width (as indicated in Figure I). In the remainder of the booklets (Set II) the size of the types employed was not varied to control for column width, with the result that comparable lines varied in width (as indicated in Figure II). Apart from the difference due to line width, the two sets were identical.

RELATIVE SIZE CUE	CASE	EXAMPLE
Irrelevant	Upper	1. THAT WE ARE AS YET QUITE IGNORANT OF EVEN THE SIMPLEST
Maintained	Lower	2. That we are as yet quite ignorant of even the simplest
	Mixed	3. tHAt we aRE as yEt qUiTE iGnoRANT oF eVEn tHe sIMpLest
Irrelevant	Upper	4. tHAT wE aRe As YeT qUiTe IgNoRaNt Of EvEn ThE sIMpLEsT
Disrupted	Lower	5. That we are as yet quite ignorant of even the simplest
	Mixed	6. ThAt We ArE As YeT qUiTe IgNoRaNt Of EvEn ThE SiMpLeSt

Figure II

Each of the six passages in a booklet were printed in one of the six typographic styles, with all styles represented in all booklets. The order of passages was not changed, but the order of conditions was determined according to a Latin Square design (Lindquist, 1953, Pp. 258ff). No condition occurred more than once in any one serial order position, and no condition preceded or followed any other condition more than once.

A total of 216 college students served as subjects, half receiving Set I and half receiving Set II booklets. Testing was conducted in group sessions, the 36 copies of each version of the test booklet being allocated to subjects at random.

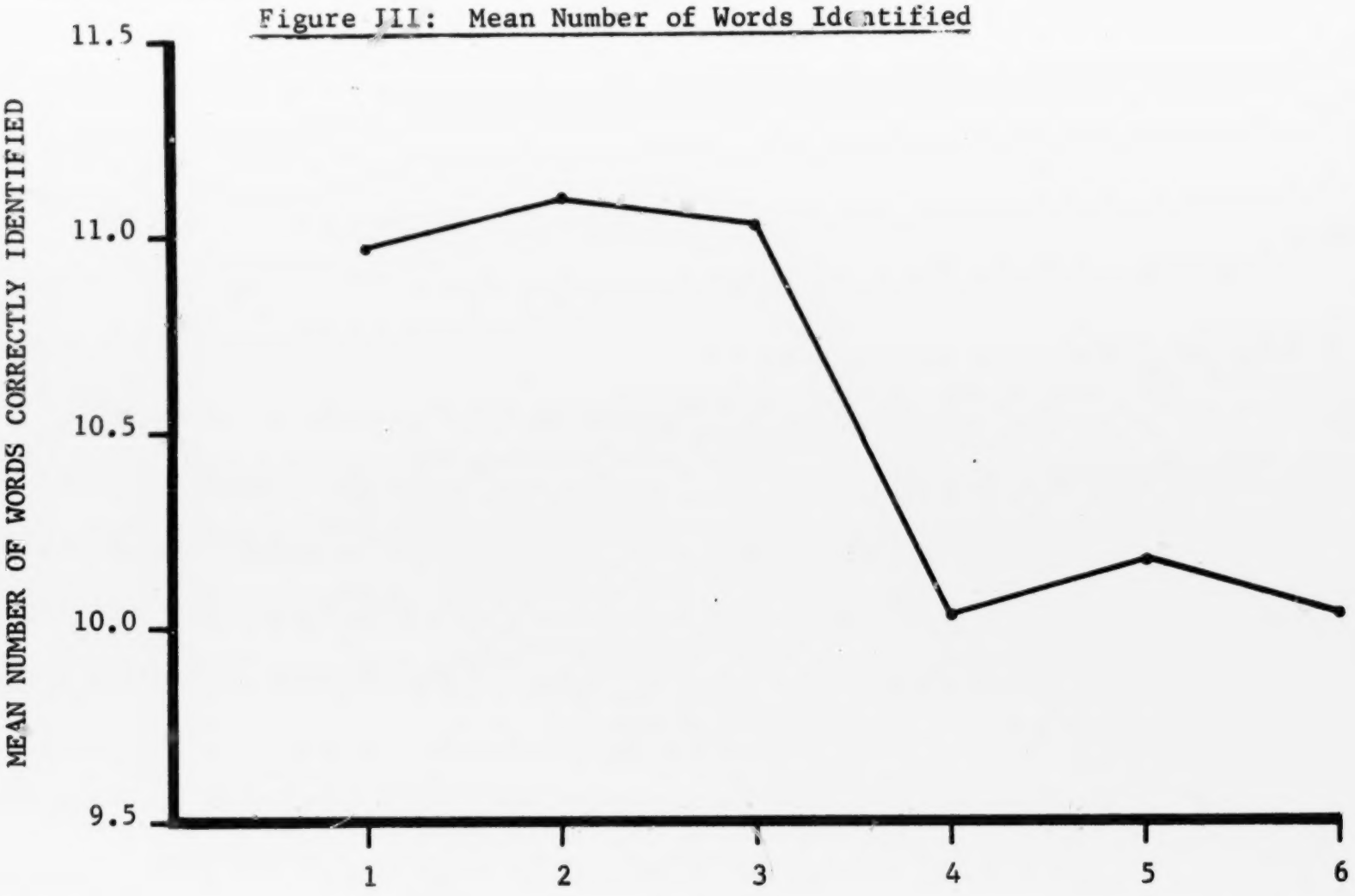
For each of the six passages the subjects were given a list of 20 words (between 4 and 8 letters in length) which occurred only once in the passage and which were not included in any other list. The passages and the lists were printed on facing pages of the test booklets: text on the left and word list on the right. The subjects were asked to find each of the listed words in the passage and to write in a box beside each test word the number of the line in which the word occurred. A short trial passage was given at the beginning of the test to assure that the subjects understood the instructions. In order to discourage the subjects from reading straight through the passage, the words in the list were presented in random order--this order was the same for all subjects. Also, to minimize any tendency to look for visual matches, the word lists were printed at random in lower, upper, and mixed case italic rather than in the Gothic print used in the passages.

The score for each passage was the number of words correctly identified by subjects during 2½ minutes.

RESULTS

There was not a significant difference between the two sets of booklets, therefore the data for both sets was combined. The results for the combined data are shown in Figure III below.

Figure III: Mean Number of Words Identified



The mean scores for the six conditions were in agreement with the first prediction--i.e., there was no reduction in the subjects' ability to identify words in which case was alternated if the size was held constant (Condition 3); whereas there was a significant reduction in the subjects' ability to identify words in which both size and case were alternated (Condition 6). The prediction that interference with the relative size of the elements of lower case print (Condition 5) would reduce the subjects' ability to identify words was also supported.

However, interference with relative size cues in upper case print (Condition 4) also resulted in a significant reduction in the subjects' ability to identify words--this condition was predicted to be no more difficult than normal upper case print (Condition 1).

An analysis of variance for repeated measures (Winer, 1962, Pp. 302-309) revealed that there was a significant difference at the .01 level between typographic conditions, but that neither the set variable nor the interaction between sets and typographic conditions was significant. A Tukey's test for the significance of differences between all possible pairs of means showed no significant difference between the three conditions in which relative size of the letters was held constant and no significant difference between the three conditions in which relative size of the letters was distorted, but each of the three constant size conditions was significantly different at the .01 level from the three mixed size conditions. These differences hold whether the two sets of data are combined or considered individually.

DISCUSSION

The results of this experiment support the hypothesis that disruption in the "total word form" does not interfere with one's ability to identify words unless discriminability of elements is disrupted, for example by mixing the size of the individual letters. The only unpredicted finding was that alternating the size of upper case letters interfered with the identification of words in a search-and-identification task whereas it did not interfere with reading upper case print when some comprehension and verbalization of response were involved (Smith, 1968).

One possible explanation for the conflicting results in the two studies lies in the difference in relative response complexity when the subject is searching for a word compared with a continuous reading task. During the reading task there is only one correct response that the subject can make to any stimulus, i.e., he can utter "transfer" whether the stimulus is TRANSFER, TrAnSfEr , or tRAnSfeR . In the search task, however, a subject looking for "transfer" in the all-capitals, mixed size condition does not know whether his "response" should be TrAnSfEr or tRAnSfeR . It has frequently been demonstrated (Garner, 1962, Pp. 35-38) that response uncertainly is more difficult to cope with than stimulus uncertainly.

If the difference is attributable to a "size" effect, as predicted by the experimental hypothesis, then it should be observed in Conditions 4, 5 and 6. If it is related to the counter hypothesis, i.e., related to word unfamiliarity, then the difference should also be apparent in Condition 3. Condition 3 is not any different from Conditions 1 and 2, so the relative difficulty of Condition 4, while not expected, is not considered damaging to the experimental hypotheses. A check on the validity of this explanation could be made by ensuring that there was no uncertainty about how mixed size items would appear, e.g., by making the first letter always large (TrAnSfEr). This would eliminate the uncertainty and should, according to the present argument, make Condition 4 as easy as Conditions 1, 2 and 3.

It is interesting to note that the differences between the easiest and most difficult conditions, while statistically significant, were

only about 10 per cent. Thus, readers are able to cope quite comfortably with disruption of total word form, even in those situations where size confusions interfere with feature discrimination.

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